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Local People's Perceptions of Changing Ecosystem Services in Baroro River Watershed, Philippines

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Abstract

Establishing the status of ecosystem services entails knowing the connection between humans and nature, since the ability of a landscape to generate ecosystem services depends largely on how it is being managed. Using the framework of livelihood, income, forest condition and ecosystem services (LIFE) and place of residence, this paper aims to understand the relationship between the local people's perceptions and ecosystem services at a given point of time. An upstream and a midstream village were selected in a watershed in Northern Philippines as a case where land use conversion, from forest to agriculture, has taken place at various time periods, to different extents, and where ecosystem services are crucial to production activities. This paper is to contribute to the limited literature on ecosystem services in the Philippines using the historical perspective of the local people. The results strongly indicate that the local people's perceptions regarding ecosystem services are consistent with land use and land cover (LULC) changes that happened in the past. Livelihood, place of residence and, to some extent, income can become good predictors of the status of ecosystem services that can be harnessed for targeted interventions in the future.

Keywords

Agricultural landscape; Ecosystem services; Forest condition; Income; Livelihood

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Introduction

Investigating ecosystem services entails knowing the connection between humans and nature (Diaz *et al.*, 2015). Ecosystem services (ES) are natural processes and functions that benefit people directly or indirectly (Costanza *et al.*, 2017). These include provisioning services, such as water and food provision; regulating services, such as climate and air quality regulation; supporting services, such as nutrient cycling; and cultural services, such as sense of place (Millennium Ecosystem Assessment [MEA], 2005). The ability of nature to generate these ecosystem services, however, depends largely on how it is being managed and protected by humans from degradation (Rode *et al.*, 2016).

With limited human interference, watersheds can provide a steady stream of ecosystem services to benefit societies. These past centuries, however, have seen an increase in the conversion of forests within watersheds into various land uses due to the increasing demand for food and settlement, and the unparalleled development and technological advancement of nations. From the 1700s to the 1980s, the total area of cultivated lands globally had increased by 466% (Meyer and Turner, 1992; Sunderland *et al.*, 2017), resulting in loss and fragmentation of habitats with critical implications for the provision of ecosystem services (Mitchell *et al.*, 2015).

This led to the creation of agricultural landscapes, a complex human-modified ecosystem composed of different socio-ecological elements (Reed *et al.*, 2016; Sunderland *et al.*, 2017). Situated within the watershed, where almost half of the world's population lives and depends on land productivity and water resources, agriculture is considered as the single most important sector providing basic necessities, such as food and fiber, to both rural and urban areas (Crist, Camilo and Engelman, 2017; Singh and Dudley, 2012).

Over time, people's dependence on natural resources for livelihood and income has brought about deforestation. Coupled with agricultural intensification and forest fragmentation, this has significantly affected the functioning of the ecosystem to the point that some ecosystem services are lost forever. Incidentally, where agriculture is, a large proportion of the population is poor, with less resources to live comfortably due to the diminishing condition of the watershed, while continuing to shoulder the burden of food production (Chen *et al.*, 2017).

As the role of humans is central to the issue of how to sustain the flow and delivery of ecosystem services in the future, studies that incorporate community perception can generate more meaningful insights about the relationship between people and their environment that has led to the current condition of the ecosystem (Martín-Lopez *et al.*, 2012; Kandel *et al.*, 2018). These types of research are scant, as most of the work on ecosystem services is mainly focused on biophysical assessment and economic valuation (Chaudhary *et al.*, 2015; Kandel *et al.*, 2018; Moutouama *et al.*, 2019). This area of interest, however, has been gaining ground in efforts to better understand the social dimension of ecosystem services, including the distribution of impact and benefits from using natural resources, and help shape policies for better management of ecosystem services at the watershed level (Baral *et al.*, 2014; Asah *et al.*, 2014; Chen *et al.*, 2017).

In the Philippines, ES studies are largely related to watershed services of the traditional rice-based system, mangroves, indigenous agriculture-based system in ancestral lands and changes in the landscape pattern in a peri-urban area in the province of Ifugao (see Tekken *et al.*, 2017; Tilliger *et al.*, 2015; Thompson, Primavera and Friess, 2017; Estoque and Murayama, 2013; Chakraborty *et al.*, 2019). Understanding the changes in ecosystem services over time is crucial in addressing many questions in the ES field (Tomscha *et al.*, 2016), which is currently lacking in the literature, especially in the Philippines. This is what this paper attempts to address.

Using a mixed methods approach, this study aims to understand the relationship between people's perceptions and status of ecosystem services at a given point of time and provide useful input for the crafting of future interventions toward the sustainable management of the watershed. An upstream and a midstream barangay[1] were selected in a watershed in Northern Philippines as a case where land use conversion, from forest to agriculture, has taken place at various time periods, to different extents, and where ecosystem services are crucial to production activities. To date, this is the first attempt to use the livelihood, income, forest condition and ecosystems services (LIFE) indicators in understanding the complex linkages between drivers of change and trends in ecosystem services, which are critical in providing baselines to inform management options in the watershed.

Perceptions and Ecosystem Services

Except for natural disasters, changes in a landscape's land use and land cover (LULC) usually result from spatial shifts in people's decisions (Moutouama *et al.*, 2019), driven by the prevailing sociocultural, institutional, economic (Martín-López *et al.*, 2012; Turner, Morse-Jones and Fisher, 2010; Hamman, Biggs and Reyers, 2016) or environmental priorities. These decisions are based on people's perception of what is beneficial to them at a given time and their level of awareness about their geographic condition. Most often than not, altering the natural cover significantly affects the ability of the landscape to produce specific ecosystem services, since some elements of the landscape cannot be replaced. This action is directly tied to people's preferences, which tend to assign greater value to those ecosystem services that are closely linked to their livelihood, at the expense of other less important ones (Cuni-Sanchez *et al.*, 2019; Moutouama *et al.*, 2019). As the drivers of landscape degradation are largely linked to human activities, the analysis of perceptions about ecosystem services is crucial in identifying people's ES demand in order to avoid negative trade-offs in the future (Iniguez-Gallardo, Halasa and Briceño, 2018).

People's perception varies through time, affecting how they deal with their environment and the ecosystem services it produces. Reconstructing historical ES will, therefore, enhance our understanding of how past ES–people interaction has led to the current condition of a given landscape, since it carries cultural identity and common historical heritage revealing important spatio-temporal patterns and dynamics (Tomscha *et al.*, 2016). Combining biophysical data from LULC maps with historical knowledge improves our appreciation of ES flow and demand (Tomscha *et al.*, 2016). This requires more place-based research in different socio-ecological contexts (Quintas-Soriano *et al.*, 2018). Exploring perceptions uncovers the ecosystem services that we cannot observe and adds important details that are not captured in maps and other data sets (Horgan, 2019). The benefits people acquire from ecosystems are the main reason they may or may not engage in sustainable practices, which then affects the continuous stream of ecosystem services (Asah *et al.*, 2014).

Several factors influence how people perceive ecosystem services. These include age, gender, education, income and place of residence (Casado-Arzuaga, Madariaga and Onaindia, 2013; Scholte, Teeffelen and Verburg, 2015; Rojas *et al.*, 2017) as well as livelihood strategy (Cuni-Sanchez *et al.*, 2019), individual needs, cultural traditions, access to ecosystem services and sources of household income (Martın-Lopez *et al.*, 2012). People's perception of ecosystem services is also closely linked to local geographical conditions, cultural characteristics, life experiences, moral beliefs and level of economic development (Rojas *et al.*, 2017; Cuni-Sanchez *et al.*, 2019). The challenge in ES research is how to examine through the differences and commonalities of perspectives in order to find convergence in managing ecological and social systems. Sustaining ecosystem services has also been identified as an important factor in poverty alleviation, especially in rural communities that are more dependent on ecosystems for their livelihood (Kandel *et al.*, 2018; Suich *et al.*, 2015). How people value their ecosystem can be best understood as a combination of

[1] A small territorial and administrative district (in the Philippines) forming the most local level of government, also known as a village.

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biophysical and sociodemographic factors (Quintas-Soriano *et al.*, 2018), since the way a society modifies an ecosystem is a function of perceptions, interest, and the values associated with it.

Conceptual Framework: Livelihood, Income, Forest Condition and Ecosystem Services (LIFE)

The conceptual framework of this study builds on the research conducted by the Center for International Forestry Research and Rights and Resources Initiatives (CIFOR-RRI) in selected countries of Asia, Africa and Latin America, including the Philippines. It investigated the impact of tenure on livelihood (L), income (I), forest condition (F) and equity (E) of forest-dependent communities—a term they coined LIFE indicators (Pulhin *et al.*, 2008). It sought to determine, through the perceptions of upland beneficiaries, if tenure had brought about positive change in the forest condition, which in turn provided livelihood and increased income, with equitable distribution of benefits by gender and social status.

These indicators were employed in this study, except for equity, which is beyond the scope of this paper. This was replaced by the ES concept in tandem with forest condition, plus another dimension, place of residence, which was added to investigate if there are patterns that could be deduced in comparing the perceptions of ecosystem services among people living in the upstream and midstream portions of a watershed. Direct dependency of people on ecosystem services is particularly high in the rural regions with high poverty incidence (Malmborg *et al.*, 2018), as they rely on land-based livelihood systems such as agriculture. It is, therefore, likely that livelihood and income can be compromised if the natural capital (forest condition and ecosystem services) is already degraded. As people are highly integrated with their local landscapes, they are also greatly affected by changes in landscape productivity (Malmborg *et al.*, 2018) and, therefore, can relate these through perceptions based on their experience in living in a particular area. Their awareness of what is happening in their landscape can be a powerful tool for reversing the degradation of ecosystem services for future generations.

Methodology

Description of the Study Area

Situated in the province of La Union, Northern Philippines, Baroro River Watershed is a single most important resource in the municipalities of San Gabriel, Bagulin, San Juan, San Fernando, Bacnotan and Santol, providing domestic water to communities and irrigation water to agricultural areas (Figure 1). It covers a total of 19,603 hectares, consisting of forested areas in the upper elevation, sparse vegetation in the mid-elevation and urban sprawl in the lower elevation. Similar to other watersheds in the country, Baroro River Watershed transitioned from a purely forested region in the 1900s into an agricultural landscape beginning in the 1980s, especially in its middle and lower sections, when population began to increase (Ramirez *et al.*, 2019).

As the original settlers of the area, the Indigenous group of Kankanaeys still resides in the upper portion of the watershed. They continue to practice rice terracing, particularly in sloping areas, which preserves the water provisioning function of Baroro River Watershed. Migrants of Ilocano and Tagalog descent occupy the middle and lower portions of the watershed and are engaged in planting rice and corn. The population of the watershed is still increasing with an annual growth rate of 2.76%, as compared to the national growth rate of 1.21%. From 55,697 individuals in 1990, the population increased to 77,166 in 2015, putting more pressure to the remaining natural resources of the watershed.

Two barangays in Baroro River Watershed were selected as the study sites: Barangay Bayabas in San Gabriel, representing the upstream watershed, and Barangay Cabaroan in San Juan for the midstream portion. Bayabas is one of the two upstream barangays of Baroro River Watershed where the headwaters

emanate that is relatively accessible from San Gabriel, while Cabaroan is the first midstream barangay between the boundaries of San Juan and San Gabriel. Focusing on these communities will test whether people's perceptions of ecosystem services correspond to LULC changes across four time periods.

Barangay Bayabas had a small population of 494 in 2015, with a negative growth rate of 0.72% from its population of 513 in 2010. In contrast, Barangay Cabaroan had a positive growth rate of 1.52% in 2015, with 1,420 individuals, from its population of 1,312 in 2010. The two barangays had also experienced different economic trajectories through the years, with vast areas in Barangay Bayabas still remaining under forest and Barangay Cabaroan almost completely embracing agriculture interspersed with permanent and semi-permanent houses.

Research Approach and Design

Following the previous work of Ramirez *et al.* (2019), a mixed methods approach was designed in this study to compare and differentiate the perceptions of upstream and midstream residents regarding the ecosystem services provided by Baroro River Watershed. Official LULC maps were first collected from the National Mapping and Resource Information Authority (NAMRIA), a government institution in charge of producing authoritative maps for the Philippines. The earliest complete set of LULC map obtained was produced in 1988, followed by the years 2003, 2010 and 2015. These maps were then crossed-validated with sheets from Google Earth Pro and later reclassified by land use type using an ArcGIS software to come up with a uniform analysis of the land use changes in the watershed through the years. The maps were validated in the field together with some residents, local government units (LGUs) and Department of Environment and Natural Resources (DENR) staff.

The survey instrument consisted of three main sections: (a) background information about the respondent, who is commonly the head of the household; (b) socioeconomic characteristics; and (c) perception of ecosystem services across the different time periods. Background information covered age, gender, educational attainment and ethnicity, while socioeconomic information pertained to land ownership, house ownership, income and sources of livelihood. The perception part used a seven-point Likert scale to determine how the respondents perceived the condition of particular ecosystem services during a given period.

To ensure the respondents understood every item in the questionnaire, local enumerators were hired —five in each barangay (village)—who had prior experience in conducting a survey as barangay health workers (BHWs). They were trained on how to get the information needed by the study, emphasizing the importance of explaining what an ecosystem service is to the respondents. The questionnaire was then pretested to check its clarity and appropriateness. On the average, the survey took approximately 1.5–2.0 hours to complete. With permission from the barangay heads through an official letter, the survey activity started in April 2018 and was completed after three weeks. This involved a total of 203 respondents, who had been chosen randomly, including 102 from Barangay Bayabas and 101 from Barangay Cabaroan (representing 81% and 30% of the barangay populations, respectively).

The enumerators had to walk several hours to reach the respondents in Barangay Bayabas, as the houses were sparsely located in high elevation areas, which contributed to the long duration of the survey. There was relative ease in conducting the survey in Barangay Cabaroan, as most of the houses were accessible through barangay and other connecting roads.

The survey data were encoded, processed, and analyzed using IBM® SPSS® Statistics 26. Descriptive statistics, such as percentage distribution and correlation analysis, were used to look for patterns and consistencies in the responses.

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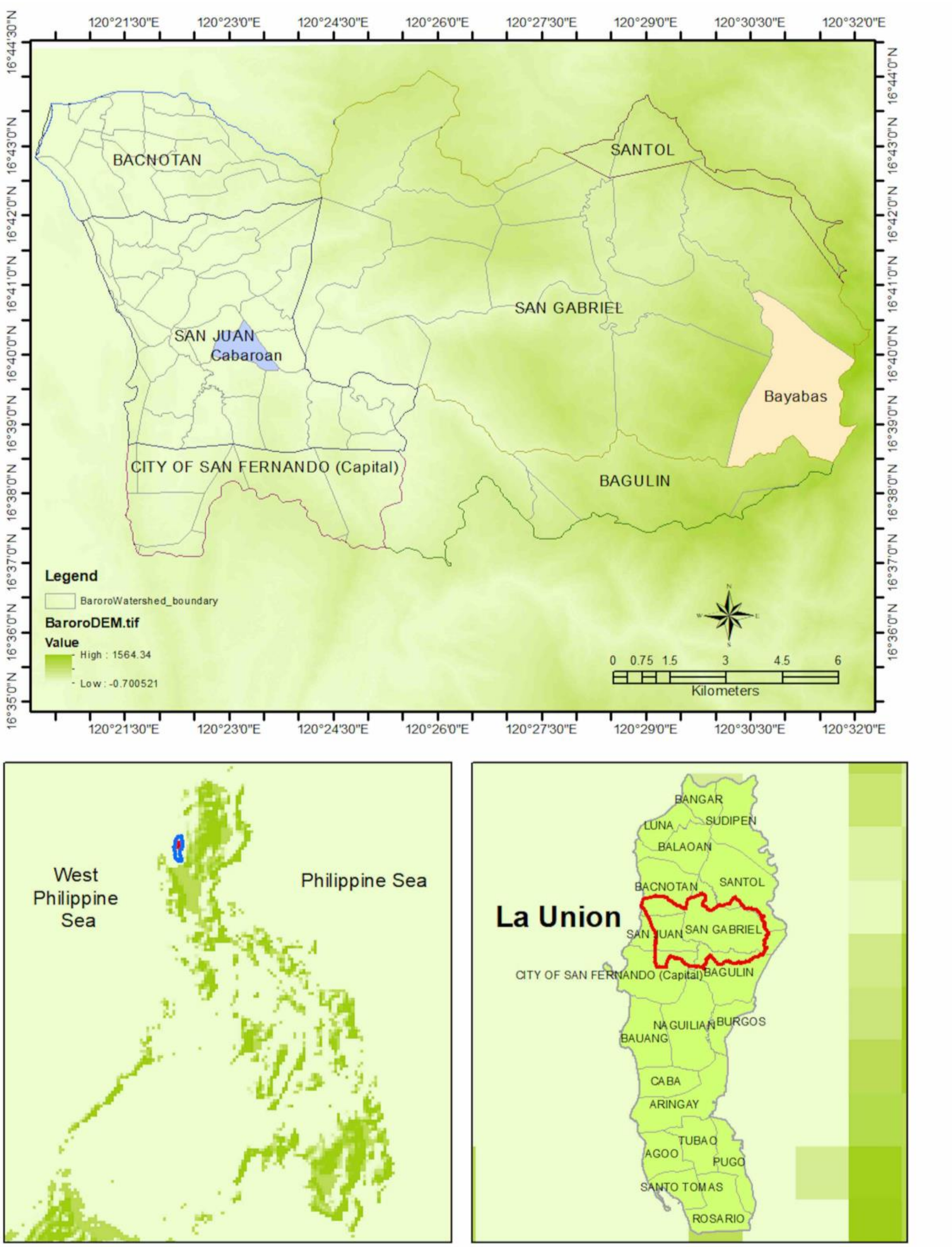

Figure 1: Location maps of Baroro River Watershed with the study sites
(Source: ARCGIS online)

Results

Land Use and Land Cover Change

With a total of 835 hectares, Barangay Bayabas is part of the Lon-oy Watershed Reservation, by virtue of Presidential Proclamation No. 378 issued in 1994, which recognizes the important role of the barangay in maintaining forest cover for the production of water for domestic and irrigation purposes. The LULC data of the barangay from 1988 to 2015, however, showed a consistent downward trend of areas under forest (Figures 2a and 2b; Table 1). The biggest decline of around -21% was recorded during the period 2010–2015, roughly the same time when agricultural areas expanded by a staggering 82%.

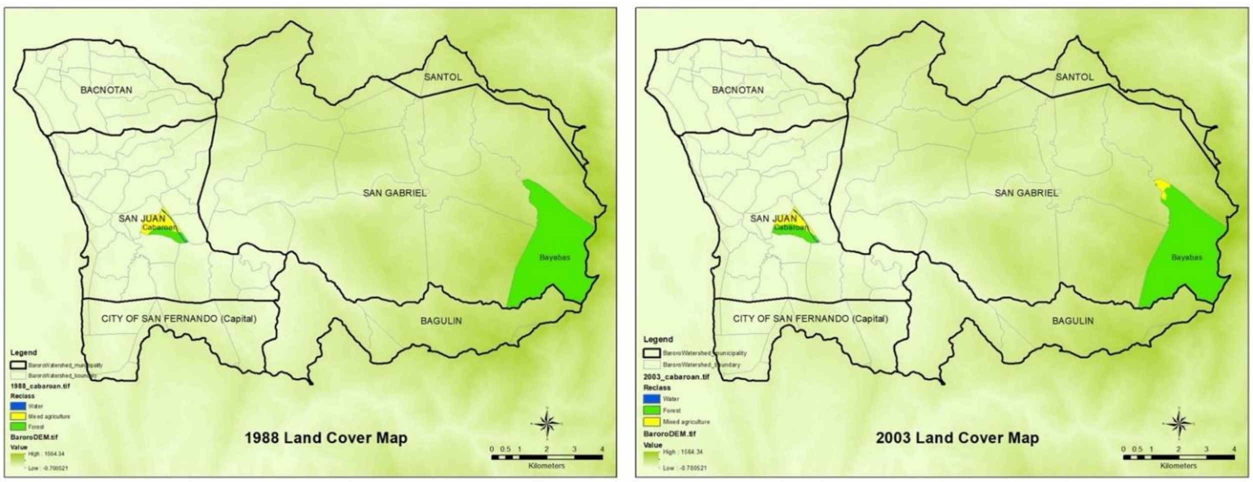

Figure 2a. LULC maps of the study sites (1998 and 2003)
(Source: NAMRIA)

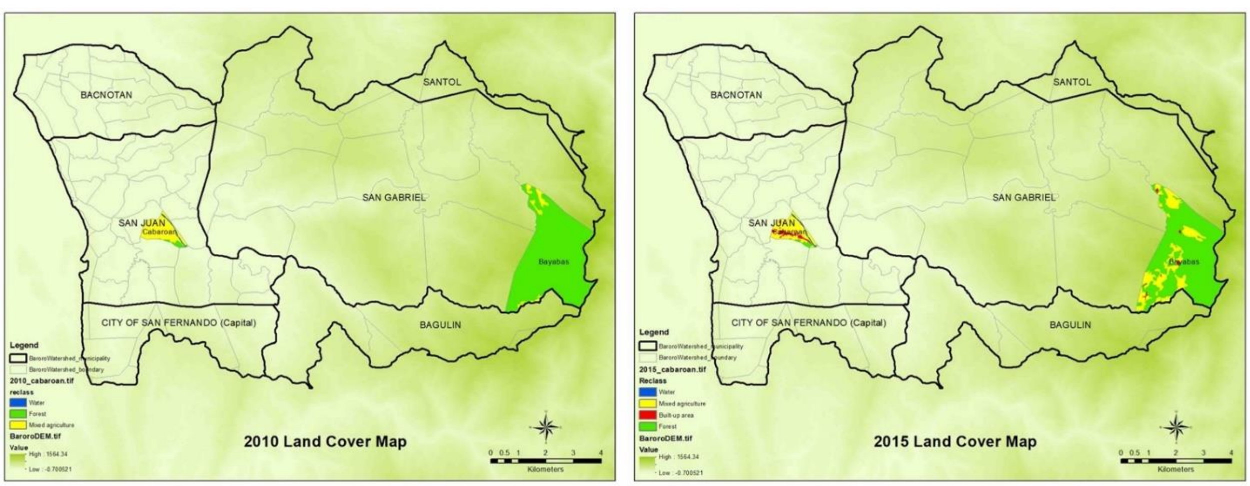

Figure 2b. LULC maps of the study sites (2010 and 2015)
(Source: NAMRIA)

Agriculture in the upper watershed was nonexistent prior to 1988 but commenced in 2003, increasing in area over time. Permanent built-up areas began to sprout in 2015. This change in forest cover would

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significantly affect the ecosystem services in the area and, if not reversed, would permanently alter the entire watershed landscape.

Table 1: LULC changes in Barangay Bayabas, 1988 to 2015 (in hectares)

LULC class	*1988*	*2003*	*2010*	*2015*	*Cover change between periods (%)*			
	Area (ha)	*Area (ha)*	*Area (ha)*	*Area (ha)*	*(1988–2003)*	*(2003–2010)*	*(2010–2015)*	*(1988–2015)*
Forest	835.00	815.06	805.18	665.49	-2.45	-1.23	-20.99	-25.47
Mixed agriculture	0	19.4	29.82	169.51	+100	+34.94	+82.41	+100
Barren land	0	0	0	0	0	0	0	0
Built-up area	0	0	0	5.59	0	0	+100	+100
Inland water	0	0	0	0	0	0	0	0

Unlike Barangay Bayabas, the forest cover of Barangay Cabaroan, totalling 108.62 hectares, increased by 32% during the period 1988–2003, after which a consistent decline in areas under forest was observed (Table 2). Interestingly, agricultural areas in the barangay had their highs and lows, decreasing by -34% in 1988–2003 and then growing by 49% in the succeeding period of 2003–2010. This could be attributed to the reforestation efforts of the Cabaroan LGU and DENR, the national government agency in charge of environmental management during that time. A decline of -17% was observed in 2010–2015. Areas under inland water did not change over time, with built-up areas starting to come out in 2015.

Table 2: LULC changes in Barangay Cabaroan, 1988 to 2015 (in hectares)

LULC Class	*1988*	*2003*	*2010*	*2015*	*Cover change between periods (%)*			
	Area (ha)	*Area (ha)*	*Area (ha)*	*Area (ha)*	*(1988–2003)*	*(2003–2010)*	*(2010–2015)*	*(1988–2015)*
Forest	36.94	54.06	7.55	6.88	31.67	-100	-9.74	-100
Mixed agriculture	66.41	49.29	95.80	81.90	-34.73	+48.55	-16.97	+18.91
Barren land	0	0	0	0	0	0	0	0
Built-up area	0	0.00	0	14.57	0	0	+100	+100
Inland water	5.27	5.27	5.27	5.27	0	0	0	0

Profile of the Respondents

In Barangay Bayabas, the respondents consisted of more males (about 68%) than females, and the average age was about 53 years. Only 17% had gone to high school, while most had reached only elementary or had not gone to school at all. More than half (around 66%) were born in the area with Kankanaey roots, while the rest were able to marry a resident of the barangay and decided to stay there. Migrants had been staying in the barangay for 27 years, on the average. Although the majority of the respondents belonged to the indigenous people's group, only 64% said they owned the land where they lived and farmed. This could be attributed to the fact that some respondents might still have living parents who were the recognized owners of the land—a usual practice among Kankanaeys.

Upland farming was the primary source of livelihood among most of the respondents (about 77%), with the mean annual income at US$875.62, which is below the poverty threshold of US$1,925.28 at the national level. When asked if this was enough to support a family of four, almost half replied in the affirmative

(46%). Since Bayabas was an upstream barangay, it was not surprising that 60% of the respondents identified upland rice as their primary crop; some planted vegetables and root crops (24%), corn (3%) and fruits such as banana (23%); and a considerable percentage (about 31%) grew tiger grass for broom making, which the municipality of San Gabriel is known for. Around 59% raised livestock, such as chicken and pigs, primarily for household consumption (12%). Livelihood opportunities were limited in the area because of the distance of Barangay Bayabas to the town proper, which is around 5 kilometers of very steep and rough road, with limited transportation. Its inaccessibility was apparently what had kept the barangay's remaining forest area intact, according to the respondents.

In Barangay Cabaroan, there were also more male than female respondents (about 60%), and the mean average age of all respondents was 62 years. As the barangay is comparatively accessible compared to Barangay Bayabas, around 45% of the respondents had obtained some elementary or high school education. Nearly all of the respondents (80%) were born in the area with Ilocano roots. Migrants had been residing in the area for an average of 35 years, primarily due to marriage. This is longer compared with the stay of migrant respondents in Barangay Bayabas, since Barangay Cabaroan is nearer and more accessible from other municipalities of La Union.

Nearly all of the respondents (92%) owned the land they were tilling. About 63% relied on farming as their main source of livelihood while others had jobs in the town proper of San Juan, a known tourist area for both local and international surfers. Their mean annual income of US$1,184.18 was slightly higher than that of Bayabas respondents, perhaps because the residents of Cabaroan had more employment opportunities. However, only 41% said that their income was enough to support the needs of their families. Around 68% planted commercial rice varieties, aside from corn (68%) and vegetables and root crops (40%), for sale in the market. Some engaged in raising livestock, including chicken (50%) and cows and cattle (37%), for both household consumption and the market.

Perceptions of Forest Condition

As both barangays were part of the watershed landscape that was covered predominantly with forests in the 1940s (Ramirez *et al.*, 2019), the respondents were asked if they had any recollection or oral histories from their elders about the decline in forest resources over time. These events were then checked if these could be traced back to the LULC change that had taken place in these areas, coinciding with the timeline of the maps on hand: 1980s (coinciding with 1988), 2000s (coinciding with 2003), and 2010s (coinciding with 2010 and 2015).

The following conditions were used to assess the status of the forest and the ecosystem services that were otherwise considered as important to the daily lives of the people: (a) number of non-timber forest products, (b) number of wild animals, (c) number of residents, (d) water supply, (e) forest cover and (f) fish stocks in Baroro River.

- Number of Non-Timber Forest Products

Non-timber forest products (NTFPs) include rattan, bamboo and medicinal plants as well as tiger grass (*Thysanolaena latifolia*) that the local people use in making brooms. Respondents from Barangay Bayabas remembered that it was in the 1980s when they started experiencing a considerable decline in the volume of NTFPs they could gather (28%), which worsened in the 2000s (43%). Fifteen percent of the respondents said that this continued until 2010s. Those from Barangay Cabaroan, on the other hand, recalled having the same experience as early as the 1970s (68%).

- Number of Wild Animals

Respondents from Barangay Bayabas noted the diminishing number of wild animals around the watershed in various periods: prior to the 1980s (24%), in the 1980s (31%) and in the 2000s (30%). By the 2010s, this decline continued, according to 7% of the respondents. Wild animals such as deer (*Rusa marianna*) and wild boar (*Sus philippensis*) were said to be common in the area in the 1960s, but their population was decimated in the succeeding decades. In Barangay Cabaroan, however, more than half of the respondents (60%) attested that the number of wild animals declined fast prior to the 1980s, continuing in the 1980s (13%) and further declining again in the 2000s (25%). Today, very rare sightings of wild animals have been reported in the barangay; they have been replaced by domestic animals.

- Number of Residents

In terms of the entry of people in the forest, some respondents from Barangay Bayabas recalled that this took place beginning in the 1980s (around 22%) and peaked in the 2000s (44%). This was still happening in the 2010s, as indicated by around 23% of the respondents. In Barangay Cabaroan, 28% of the respondents claimed that people started settling in the barangay prior to the 1980s, onto the 1980s (35%) and the 2000s (27%). A lower proportion of respondents (9%) noted that this took place again in the 2010s.

- Volume of Water Supply

About 21% of the respondents from Barangay Bayabas confirmed that the decline in water supply was evident beginning in the 1980s, with almost the majority (45%) claiming that the highest decline happened in the 2000s. More than a fourth of them (27%) noted its occurrence until the 2010s, when rivers and their tributaries experienced an intermittent flow of water. In Barangay Cabaroan, 45% of the respondents started experiencing water shortage in the 1980s, which remained a problem in the 2000s for 28% of the respondents and in the 2010s for 23%.

- Forest Cover

In Barangay Bayabas, most of the respondents observed that forest cover suffered a serious decline, with 43% saying that this happened in the 2000s and about a fourth pointing to the period of the 1980s, when timber, such as narra (*Pterocarpus indicus*), red lauan (*Shorea negrosensis*) and yakal (*Shorea astylosa*), were harvested for sale. Seventeen percent remembered that this condition of the forest continued up to the 2010s. In Barangay Cabaroan, 25% of the respondents recalled that clearing of forest cover for agriculture began in the 1980s and continued throughout the succeeding decades of 1980s (19%) and 2000s (14%). This coincided with the entry of migrants to the area due to the promise of agriculture. At present, trees are still being cut in the area for charcoal making to address the demands of hotels and restaurants in San Juan.

Notwithstanding the depletion of forest resources through the years, the respondents were also asked if the forest began to regain its tree cover. Around 31% of the respondents from Barangay Bayabas witnessed government efforts toward reforestation in the 2000s, continuing up until the 2010s (35%). An almost similar proportion of respondents from Barangay Cabaroan observed the same projects being implemented in their area in the 2000s (42%) and 2010s (38%) either by the LGUs or DENR.

- Fish Stocks

Traditionally, Baroro River was known as the habitat of *ipon* (*Awaous melanocephalus*, juvenile stage) and other freshwater species such as *hito* (*Clarias batrachus*) and eel (*Anguilla marmorata*), which were a

source of protein for families. Twenty-nine percent of respondents from Barangay Bayabas stated that the disappearance of fish stocks began in the 1980s but became more pronounced in the 2000s (54%). In Barangay Cabaroan, nearly half of the respondents (45%) said that fish decline was noticeable in the 1980s and continued in the 2000s (24%) and the 2010s (28%).

Table 3: Livelihood and perception of ecosystem services during different periods using Chi-square test statistics of the Friedman test

Ecosystem services		*Livelihood or income source*													
		Farming							*Non-farming*						
		n	*Mean rank*			*Chi-square*	*p-value*		*n*	*Mean rank*			*Chi-square*	*p-value*
			1980s	*2000s*	*2010s*					*1980s*	*2000s*	*2010s*		
Freshwater production	Continuous flow of water in the rivers	110	2.4	1.6	2.0	39.00	0.000*		51	2.3	1.8	1.9	10.79	0.005*
	Clear water in the rivers	109	2.4	1.7	2.0	38.91	0.000*		51	2.3	1.8	2.0	8.21	0.017*
	Continuous supply of water in the houses	112	2.3	1.7	2.0	27.76	0.000*		51	2.2	1.8	1.9	6.01	0.049*
	Clear water supply in the houses	98	2.1	1.9	1.9	4.74	0.094		46	2.0	2.1	1.9	1.83	0.400
Soil productivity	Rice production	112	2.3	1.8	1.9	18.93	0.000*		49	2.1	2.1	1.8	4.44	0.109
	Vegetable production	113	2.3	1.8	1.9	25.41	0.000*		49	2.1	2.2	1.8	4.78	0.092
	Fruit production	113	2.3	1.8	1.9	22.44	0.000*		49	2.2	2.1	1.8	5.34	0.069
	Pests and diseases	106	1.9	2.3	1.8	16.02	0.000*		44	1.9	2.1	2.0	0.41	0.813
	Use of chemical fertilizer	100	1.9	2.0	2.0	0.83	0.660		42	2.0	1.9	2.1	0.63	0.729
	Use of chemical pesticide	98	1.9	2.1	2.0	1.28	0.526		41	2.0	2.0	2.0	0.13	0.938
Food, fiber and raw materials	Supply of fish in the river	113	2.6	1.7	1.8	66.93	0.000*		49	2.3	1.9	1.8	9.99	0.007*
	Supply of non-timber forest products	107	2.3	1.8	1.9	25.08	0.000*		42	2.1	2.0	1.9	2.55	0.279
	Supply of medicinal plants	108	2.3	1.9	1.8	24.31	0.000*		45	2.1	2.0	1.9	2.08	0.354
	Supply of timber	103	2.3	1.8	1.9	18.95	0.000*		44	2.0	2.0	1.9	0.29	0.864

Ecosystem services		*Livelihood or income source*											
		Farming						*Non-farming*					
		n	*Mean rank*			*Chi-square*	*p-value*	*n*	*Mean rank*			*Chi-square*	*p-value*
			1980s	*2000s*	*2010s*				*1980s*	*2000s*	*2010s*		
Maintenance of biodiversity	Number of trees in the forest	112	2.1	1.7	2.2	25.95	0.000*	45	2.0	2.0	2.0	0.26	0.878
	Number of plants in the forest	112	2.2	1.8	2.0	20.16	0.000*	47	2.1	2.0	1.9	1.90	0.387
	Number of wild animals in the forest	110	2.2	1.8	2.0	24.67	0.000*	48	2.3	1.9	1.8	7.48	0.024*
	Number of fish in the rivers	108	2.3	1.8	2.0	24.71	0.000*	46	2.3	1.9	1.9	5.78	0.056
Cultural services	Quality of tourist spots inside the forest	113	2.12	2.07	1.81	9.51	0.009*	49	2.06	2.01	1.93	0.62	0.734
	Sacred areas	95	2.19	1.97	1.84	11.11	0.004*	43	1.92	2.33	1.76	10.44	0.005*
Micro-climate	Fresh air from the environment	110	2.22	2.08	1.70	29.69	0.000*	47	2.21	1.96	1.83	5.38	0.068

*Indicates significance at 5% probability level

Perceptions of Ecosystem Services

The perception of respondents regarding the condition of selected ecosystem services was examined vis-à-vis their livelihood, income and place of residence in a given period. Following the Millennium Ecosystem Assessment (MEA), the ecosystem services the local key informants encountered in their daily lives and thus were most familiar with were included. These were freshwater production, soil productivity, preservation of biodiversity, provision of food, fiber and raw materials, cultural services and maintenance of microclimate.

Based on recollection, the respondents rated the condition of a specific ecosystem service using a 7-point Likert scale: worst (-3), worse (-2), bad (-1), neutral (0), good (+1), better (+2), best (+3). The data were then processed using the Friedman test, a non-parametric test with repeated measures (across the different time periods), to check the differences between or among groups when the dependent variable being measured is ordinal. The mean rank was computed to reflect the approximate condition of a particular ecosystem services in a given period and a p-value was obtained to determine whether there is a significant difference in the responses or if the variables being tested are related, when the p-value is < 0.05. However, as some respondents were not yet born/living in the watershed or had no recollection yet of what happened prior to or during the 1980s, the responses did not account for the total number of respondents (n=203).

- Livelihood and Perceived Changes in Ecosystem Services

The forms of livelihood in both barangays were categorized as farming and non-farming. For about 70% of the respondents, farming was the primary source of income. The rest were working for the government, employed in the tourism industry in San Juan or working as laborers in nearby municipalities.

Among those into farming, almost all of the perceived changes in ecosystem services indicated a significant difference or correlation ($p<0.05$), except those referring to clear water supply ($p=0.094$), use of chemical fertilizer ($p=0.660$) and use of chemical pesticides ($p=0.526$; Table 3). Across all types of ecosystem services, there was a pattern of declining mean ranks from the 1980s to the 2000s, followed by increasing mean ranks from the 2000s to the 2010s. The improving perception of ecosystem services could be attributed to the respondents' growing awareness of the initiatives of the San Gabriel and San Juan LGUs to plant trees in the degraded parts of the watershed and to promote organic agriculture using manure for fertilizer and integrated pest management (IPM) to ward off pests starting in the late 1990s. Only those referring to cultural services and microclimate were declining in mean ranks throughout the three periods.

Of those into non-farming activities as their source of livelihood or income, perceptions of ecosystem services through time mostly had p-values >0.05, indicating that there was no significant difference or correlation among these variables. Correlation was noted only in perceptions of freshwater production (with p-values <0.05) as well as supply of fish in the river ($p=0.007$), number of wild animals in the forest ($p=0.024$) and sacred areas ($p=0.005$) under cultural services. The mean ranks of those with correlation declined from the 1980s to the 2000s and then slightly increased from the 2000s to the 2010s. This is similar to the pattern shown by those into farming, since water use is common to all. Diminishing mean ranks were noted from the 1980s to the 2010s for the supply of fish in the river ($p=0.07$), consistent with the observation of Garcia (2017), and for sacred areas ($p=0.005$).

- Income and Perceived Changes in Ecosystem Services

Using the median annual income as a reference, the respondents were categorized into two groups: those with annual income lower than US$600 and those with annual income higher than US$600 (Table 4). Among lower-income respondents, perceptions of freshwater production had p-values <0.05, which signified correlation. The case was not the same for clear water supply in the house ($p=0.891$). Correlation of income with other variables was noted in perceptions of food, fiber and raw materials among lower-income respondents (all with $p<0.05$), but not for supply of timber ($p=0.067$). Correlation was also found for maintenance of biodiversity (all with $p<0.05$) and microclimate ($p=0.002$).

Table 4: Income and perception of ecosystem services during different periods using Chi-square test statistics of the Friedman test

Ecosystem services		*Annual income (in US dollars)*											
		Less than 600						*600 and above*					
		n	*Mean rank*			*Chi-square*	*p-value*	*n*	*Mean rank*			*Chi-square*	*p-value*
			1980s	*2000s*	*2010s*				*1980s*	*2000s*	*2010s*		
Freshwater production	Continuous flow of water in the rivers	74	2.2	1.8	2.0	10.44	0.005*	92	2.4	1.6	2.0	35.29	0.000*
	Clear water in the rivers	73	2.2	1.8	2.0	6.79	0.034*	91	2.5	1.6	1.9	42.05	0.000*

Ecosystem services		*Annual income (in US dollars)*											
		Less than 600						*600 and above*					
		n	*Mean rank*			*Chi-square*	*p-value*	*n*	*Mean rank*			*Chi-square*	*p-value*
			1980s	*2000s*	*2010s*				*1980s*	*2000s*	*2010s*		
	Continuous supply of water in the houses	75	2.2	1.8	2.0	7.28	0.026*	94	2.3	1.7	2.0	25.01	0.000*
	Clear water supply in the houses	66	2.0	2.0	2.0	0.23	0.891	82	2.2	1.9	1.8	10.87	0.004*
Soil productivity	Rice production	73	2.1	2.0	1.9	2.94	0.230	93	2.3	1.8	1.9	19.53	0.000*
	Vegetable production	73	2.2	2.0	1.9	3.78	0.151	93	2.3	1.8	1.8	21.19	0.000*
	Fruit production	73	2.2	2.0	1.9	4.17	0.124	92	2.4	1.8	1.9	22.58	0.000*
	Pests and diseases	67	1.9	2.1	2.0	3.64	0.162	75	2.0	2.3	1.8	14.85	0.001*
	Use of chemical fertilizer	64	2.0	1.9	2.1	1.30	0.523	74	1.9	2.1	2.0	1.46	0.482
	Use of chemical pesticide	62	2.0	1.9	2.1	2.18	0.336	73	2.0	2.2	1.9	5.27	0.072
Food, fiber and raw materials	Supply of fish in the river	73	2.4	1.8	1.9	20.95	0.000*	92	2.6	1.8	1.7	50.77	0.000*
	Supply of non-timber forest products	71	2.2	1.9	1.9	8.47	0.014*	76	2.3	1.9	1.8	21.16	0.000*
	Supply of medicinal plants	72	2.3	1.9	1.9	11.32	0.003*	84	2.3	1.9	1.8	13.03	0.001*
	Supply of timber	67	2.2	1.9	1.9	5.39	0.067	77	2.2	1.9	1.9	8.27	0.016*
Maintenance of biodiversity	Number of trees in the forest	70	2.1	1.8	2.2	7.05	0.030*	89	2.1	1.8	2.2	9.78	0.008*
	Number of plants in the forest	72	2.2	1.8	2.0	7.92	0.019*	91	2.2	1.9	1.9	10.45	0.005*
	Number of wild animals in the forest	69	2.2	1.8	2.0	12.95	0.002*	89	2.2	1.9	1.9	12.80	0.002*
	Number of fish in the rivers	67	2.2	1.7	2.0	11.26	0.004*	87	2.3	1.9	1.9	16.24	0.000*
Cultural services	Quality of tourist spots inside the forest	73	2.03	1.99	1.99	0.12	0.940	90	2.14	2.15	1.71	15.44	0.000*
	Sacred areas	67	2.01	2.13	1.87	3.49	0.175	82	2.20	2.01	1.80	9.83	0.007*
Micro-climate	Fresh air from the environment	70	2.19	2.06	1.74	12.03	0.002*	89	2.25	2.07	1.67	26.79	0.000*

*Indicates significance at 5% probability level

Freshwater production had a pattern of declining mean ranks from the 1980s to the 2000s and then increasing mean ranks from the 2000s to the 2010s, indicating an improving condition of water. The pattern observed

for maintenance of biodiversity was the same, which could mean that habitats previously in some stages of destruction were improving and stakeholders' efforts to plant trees were paying off. The mean ranks for the perceptions of food, fiber and raw materials declined from the 1980s to the 2000s, with no movement recorded from the 2000s to the 2010s. Microclimate had declining mean ranks throughout the three periods.

Among higher-income respondents, all perceptions of ecosystem services had a correlation ($p<0.05$), except the use of chemical fertilizer ($p=0.482$) and use of chemical pesticide ($p=0.072$). Similar to those under the lower-income bracket, mean ranks declined from the 1980s to the 2000s and then increased from the 2000s to the 2010s for freshwater production (all with $p<0.05$). This was also the trend for rice production ($p=0.000$), fruit production ($p=0.000$) and pest and diseases ($p=0.001$). Perceptions of food, fiber and raw materials (all with $p<0.05$) had decreasing mean ranks from the 1980s to the 2010s, while those pertaining to the maintenance of biodiversity (all with $p<0.05$) had decreasing mean ranks from the 1980s to the 2000s, with no change from the 2000s to the 2010s. Both cultural services and microclimate (all with $p<0.05$) yielded decreasing mean ranks throughout the three time periods.

- Place of Residence and Perceived Changes in Ecosystem Services

In Barangay Bayabas, except for the sacred areas ($p=0.130$), all perceptions of ecosystem services yielded significant differences ($p=0.000$), which implies their correlation with the place of residence. For freshwater production, there was a consistent decrease in the mean ranks of perception in all variables ($p=0.000$) throughout the three periods. This means the respondents saw a steady decline in the quality and quantity of water from the watershed (Table 5). This was the same pattern observed in their perceptions of soil productivity for rice, vegetable, and fruit production (all with $p=0.000$). Consistent with the initiative of local officials to shift to organic agriculture, perceptions of the use of chemical fertilizer ($p=0.000$) and pesticides ($p=0.000$) in the barangay were declining. This contributed to the respondents' weakening perceptions regarding pests and diseases ($p=0.000$) from the 1980s until the 2010s.

Regarding food, fiber and raw materials, decreasing mean ranks were noted for supplies of fish, NTFPs, medicinal plants and timber (all with $p=0.000$) throughout the years. This could be attributed to the harvesting of naturally grown timber such as *narra* (*Pterocarpus indicus*), red *lauan* (*Shorea negrosensis*) and *yakal* (*Shorea astylosa*) for sale in the 1980s, which also affected the areas planted to NFTPs, including bamboo and giant ferns. Biodiversity took a hit with the declining numbers of trees, plants, wild animals and fish (all with $p=0.000$) over the three time periods. Perceptions of cultural services, particularly sacred areas ($p=0.130$), were beyond the significance level, while declining mean ranks continued for fresh air ($p=0.000$), indicating an adverse condition for microclimate in the barangay.

Contrastingly, in Barangay Cabaroan, perceptions of the different ecosystem services mostly yielded varying trends across the time periods. While there were declining mean ranks for the variables of freshwater production ($p=0.00$) from the 1980s to the 2000s, an upward movement was noted in the 2010s, denoting the increasing quality and quantity of water flowing from the rivers and their tributaries. The mean ranks for rice ($p=0.013$), vegetable ($p=0.043$) and fruit production ($p=0.023$) decreased from the 1980s to the 2000s but stabilized in the 2010s. The reverse was true for pests and diseases ($p=0.000$), with mean ranks increasing from the 1980s to the 2000s, and then decreasing in 2010s. This could be associated with the perception that farmers were heavily using chemical fertilizers and pesticides (all with $p=0.000$) beginning in the 2000s up until the 2010s.

Perceptions of ecosystem services that had no correlation with place of residence included the following: supply of NTFPs ($p=0.213$), supply of medicinal plants ($p=0.051$) and supply of timber ($p=0.074$), as well as maintenance of biodiversity, cultural services and microclimate. The mean ranks for supply of timber

(p=0.074) declined in the 1970s to the 1980s but went up starting in the 2000s, implying that the number of trees (p=0.000) was growing again in the barangay. The volume of fish in the rivers (p=0.000) was perceived to be declining in the 1980s to the 2000s, but the mean ranks for this increased in the 2000s up to the 2010s. Cultural services such as sacred areas (p=0.013) obtained declining mean ranks across the three periods.

Table 5: Place of residence and perception of ecosystem services during different periods using Chi-square test statistics of the Friedman test

Ecosystem services		*Place of residence*													
		Bayabas							*Cabaroan*						
		n	*Mean rank*			*Chi-square*	*p-value*		*n*	*Mean rank*			*Chi-square*	*p-value*	
			1980s	*2000s*	*2010s*					*1980s*	*2000s*	*2010s*			
Freshwater production	Continuous flow of water in the rivers	63	2.6	1.8	1.5	57.13	0.000*		98	2.1	1.6	2.3	33.98	0.000*	
	Clear water in the rivers	63	2.6	1.9	1.6	44.22	0.000*		97	2.2	1.6	2.2	32.15	0.000*	
	Continuous supply of water in the houses	63	2.6	1.8	1.6	58.01	0.000*		100	2.1	1.7	2.3	23.72	0.000*	
	Clear water supply in the houses	57	2.6	1.8	1.6	47.18	0.000*		87	1.8	2.1	2.1	12.58	0.002*	
Soil productivity	Rice production	62	2.4	2.1	1.5	31.90	0.000*		99	2.2	1.8	2.1	8.75	0.013*	
	Vegetable production	62	2.4	2.1	1.5	44.94	0.000*		100	2.1	1.8	2.1	6.31	0.043*	
	Fruit production	62	2.5	2.0	1.6	38.11	0.000*		100	2.1	1.8	2.1	7.55	0.023*	
	Pests and diseases	63	2.3	2.1	1.6	22.83	0.000*		87	1.7	2.3	2.1	22.71	0.000*	
	Use of chemical fertilizer	56	2.5	1.9	1.7	33.75	0.000*		86	1.6	2.1	2.3	29.44	0.000*	
	Use of chemical pesticide	55	2.5	1.8	1.6	37.24	0.000*		84	1.6	2.2	2.2	33.30	0.000*	
Food, fiber and raw materials	Supply of fish in the river	63	2.8	1.7	1.5	83.08	0.000*		99	2.3	1.8	2.0	16.96	0.000*	
	Supply of non-timber forest products	63	2.7	1.8	1.5	72.75	0.000*		86	1.9	1.9	2.1	3.09	0.213	
	Supply of medicinal plants	64	2.8	1.8	1.4	82.37	0.000*		89	1.9	2.0	2.2	5.95	0.051	
	Supply of timber	63	2.6	1.8	1.6	44.28	0.000*		84	1.9	1.9	2.2	5.21	0.074	
Maintenance of biodiversity	Number of trees in the forest	63	2.6	1.7	1.8	42.58	0.000*		94	1.7	1.9	2.4	39.10	0.000*	
	Number of plants in the forest	63	2.7	1.6	1.7	62.96	0.000*		96	1.9	2.0	2.2	8.38	0.015*	
	Number of wild animals in the forest	62	2.6	1.7	1.8	55.16	0.000*		96	2.0	1.9	2.1	4.73	0.094	

Ecosystem services		*Place of residence*											
		Bayabas						*Cabaroan*					
		n	*Mean rank*			*Chi-square*	*p-value*	*n*	*Mean rank*			*Chi-square*	*p-value*
			1980s	*2000s*	*2010s*				*1980s*	*2000s*	*2010s*		
	Number of fish in the rivers	61	2.8	1.6	1.6	71.37	0.000*	93	2.0	1.9	2.2	5.59	0.061
Cultural services	Quality of tourist spots inside the forest	63	2.27	1.95	1.78	13.82	0.001*	99	1.99	2.12	1.89	3.45	0.178
	Sacred areas	44	2.13	2.02	1.85	4.08	0.130	94	2.10	2.11	1.79	8.68	0.013*
Micro-climate	Fresh air from the environment	61	2.61	2.06	1.34	68.67	0.000*	96	1.97	2.04	1.99	0.41	0.816

*Indicates significance at 5% probability level

Discussion

The results strongly indicate that local people's perceptions of forest condition and ecosystem services through the different time periods were consistent with the LULC change that happened in the past decades on the two study sites. This supports the findings of Ramirez *et al.* (2019) that people in the watershed are knowledgeable in their environmental situation and can accurately recall the status of ecosystem services in a given period. Even without formal exposure to the ES concept, they can relate to the benefits they derive from the watershed and assess the condition of their environment through recollection (Moutouama *et al.*, 2019). Major events with respect to the status of the environment are recorded in people's memory (Mugari *et al.*, 2019), so when they were asked about the status of the forest and when deforestation started to happen, their responses, as gleaned from the results of the survey, seamlessly matched the trends shown in the LULC maps. The downward trajectory of almost all ecosystem services in the upstream barangay over the years was consistent with the land use change as the forest was opened up for agriculture.

It is interesting to note, however, that the rate of decline in forest cover was not similar in the midstream barangay, where natural cover was almost completely decimated in the past four decades. This might have to do with the land use practices of the upland people, who still practice traditional farming systems, such as rice terracing, which is heavily reliant on the freshwater provisioning function of the watershed. This indigenous land practice has been learned over generations as the majority of the residents were born in the area while the migrants have embraced the values of the Indigenous group. Land ownership is also informal, as land can be bequeathed only by the next of kin, which brings about strong attachment to the land, its environment and the ecosystem services it provides. In contrast, ownership of land in the midstream area is primarily for agricultural production to address the demands of the outside market. The increasing number of people is more threatening to the condition of the midstream barangay than that of the upland barangay due to the uniqueness of its population composition.

The capacity of landscapes to provide ecosystem services is determined by biophysical characteristics, such as vegetation, animals and other species (Tomscha *et al.*, 2016), which is still the case in Barangay Bayabas. In contrast, the declining quality and quantity of ecosystem services in the midstream areas, particularly water production and soil nutrients, has forced the people to rely on substitutes, such as chemical fertilizers and pesticides, which do more harm than good. This also has an adverse effect on income and livelihood, which unfortunately leads to more unsustainable land practices (Ramirez-Gomez *et al.*, 2015), as depicted in Barangay Cabaroan, which has seen a consistent use of inorganic fertilizers and pesticides over the years.

This practice can degrade rather than enhance the ecosystem capacity to produce ecosystem services in the long run (Villamagna, Angermeier and Bennett, 2013).

In terms of livelihood, farming turns out to have a significant relationship with the perception of ecosystem services, compared with non-farming activities, which yielded the opposite results. This affirms the findings of Malmborg *et al.* (2018) indicating that those who depend on ecosystem services for their livelihood tend to be highly integrated with their local landscape.

While the incomes in both barangays were below the poverty threshold, those with annual income above the median tended to relate better with most of the ecosystem services. Those with annual income below the median appeared to have no significant relationship with ecosystem services, particularly soil productivity, clean water supply and cultural services. One possible explanation to this trend is that people with less income tend to make livelihood decisions at the expense of some ecosystem services. This is supported by the poverty study of Masron and Subramaniam (2018).

Based on our data, a significant predictor of perception of ecosystem services is the place of residence. The perceptions of those living in the upstream were mostly correlated, while only those ecosystem services with a bearing on agricultural production, such as freshwater production and soil productivity, had a significant relationship for those in the midstream.

The results of this study further suggest that urbanization tends to affect the people’s perception of ecosystem services, as shown in the midstream barangay of Cabaroan, which is proximate to the surfing area of the municipality of San Juan. This finding is similar to that of Moutouama *et al*. (2019). The increase in built-up area in the barangay is a clear sign that it is transitioning to urban land use, which if not regulated may bring negative consequences to the ecosystem services in the area. Urbanization somehow disconnects people from their environment, where everything has a substitute, such as bottled water for freshwater, which is otherwise freely available. A trade-off analysis regarding urbanization is necessary in the immediate future to establish science-based facts for decision making and provide a balance between the environment and development.

Generally, perceptions, attitudes and practices of the local people toward ecosystem services can be positively influenced by increasing their knowledge through planning and other information dissemination strategies. This can be reinforced by looking at the LIFE indicators, plus the place of residence. This will bridge the gap between science and practices that are otherwise relegated to the dustbins of history without seeing practical application on the ground. The importance of ecosystem services, biodiversity and forest resources needs to be properly imparted to communities, local governments and other stakeholders so that watershed and agricultural landscapes can continue to provide ecosystem services in support of livelihood and industries through appropriate and timely interventions.

Conclusion

Using people’s perceptions of ecosystem services and LULC data through time, this study is the first attempt to employ the LIFE indicators, plus place of residence, in examining a given landscape in the Philippines. The findings provide empirical evidence that people’s perceptions coincide with changes in land use cover and status of ecosystem services in Baroro River Watershed. Appreciation of spatial and temporal changes in the watershed landscape can be adequately explained by people’s perception, especially among those living close to their natural environment. Restoration of the midstream watershed, on the other hand, can proceed by harnessing the relationship of the people with ecosystem services in the agricultural landscape, which is critical to a sustainable future.

The study also used the LIFE indicators and place of residence as powerful tools to predict the changing perceptions of people toward ecosystem services in a watershed landscape. These are helpful in anticipating issues in the delivery of ecosystem services and avoid costly substitutes that can otherwise harm the environment instead of harnessing it. This approach of combining historical LULC data and people's perception can aid decision makers and stakeholders in arriving at more informed land-use decisions, which affect the future supply of ecosystem services in a given landscape.

As this type of study is place-dependent, the conduct of more research studies in other landscapes in the country is encouraged using the LIFE indicators, plus place of residence. Including the effects of climate change in the ES bundles is also recommended, as this will significantly alter scenarios that only consider spatial modifications through time.

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Authors' Declarations and Essential Ethical Compliances

Authors' Contributions (in accordance with the ICMJE criteria for authorship)

Contribution	Author 1	Author 2	Author 3
Conceived and designed the research or analysis	Yes	Yes	No
Collected the data	Yes	No	No
Contributed to data analysis & interpretation	Yes	Yes	Yes
Wrote the article/paper	Yes	No	No
Critical revision of the article/paper	Yes	Yes	No
Editing of the article/paper	No	Yes	Yes
Supervision	No	Yes	Yes
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